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Disruption-based Innovations for Incumbent Technology Businesses

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Disruptive innovation has been the subject of countless research since the term was coined by Christensen back in 1997. This research, however, looks at the topic from a new angle – that of the business being disrupted. The research presents an attempt to model and support strategic business risk management based on threats coming from disruptive innovation in the market from the incumbent technology or business's point of view. We present three different theoretical paradigms, build hypotheses upon those paradigms, and then proceed to test those hypotheses. The results of the research include mapping the presented theorems onto the world of business, and assessing their impact on long-term business planning and strategic risk management practices.

Keywords: *Disruptive Innovation; Innovation Paradigms; Incumbent Technology; Risk Management; Strategic Management; Business Planning.*

1. Introduction

After “Big Data” in 2014, “disruptive” appears to be the new trend and buzz word of 2015 (Tolido, 2015). Nonetheless, a deeper look into available literature on the subject reveals an interesting phenomenon: people in business and academia are studying disruptive innovation mainly from a proactive application perspective attempting to answer the questions: how to make it happen, and how to benefit from it? The research community seems to have neglected an important aspect of disruptive innovation and should instead attempt to answer the following question: how to protect your investments from being demolished by the competition’s disruptive technologies? Every time a disruptive technology emerges, there are two distinctive waves that are worth studying in the market: the first wave is *the incumbent technology wave*, which is the existing technology that dominates the market, and occupies the largest share of existing manufacturing and assembly lines. The incumbent wave starts high up in market share rates, and gradually loses market share to the second wave; the disruptive wave, which begins to eat up market share from incumbent technology, until it reaches full domination as shown in Figure 1.

Because a disruptive wave comes with enormous business potentials, every technology business is trying to build a product that can disrupt the market, and most research literature focuses on how to *be in the disruptive wave*. In his first book about the subject, Clayton M. Christensen (1997) has established the grounds for studying disruptive innovation from an academic perspective. His research and theories have become very popular, and they practically opened a Pandora’s Box of journal articles and papers that study and analyze disruptive innovation. Most of the existing literature, however, focus on creating disruption, and getting value out of it. Very little research currently focuses on the characteristics of the other wave; *the incumbent technology wave*, or, in order words, no one seems to be trying to study the technology that is under attack. Despite its abundance, research that focuses on “driving innovation” or “driving disruption” may not be of real value to the business community. Also, there is no guarantee that any innovation, no matter how great, is going to disrupt the market. On the other hand, studying the phenomenon from the incumbent’s point of view (i.e., the technology being disrupted, and/or business(es) that benefit from or invest in this technology) can be of significant academic and economic value.

1.1 Research Problem

This research identifies an important gap in relevant literature, and attempts to cover it via systematic research approaches. This gap is evident through the lack of extensive research that focuses on protection of incumbent technology-based businesses, and securing their investments against disruptive waves initiated by the competition. As there is an abundance of literature that focuses on the disruptive wave, this research focuses on the following research question: *How can technology businesses protect their investments against disruptive waves to ensure business sustainability and continued profitability?* This research problem includes several long term sub-components, such as:

- Integrating a defensive logic into the business planning process, and adding scorecard metrics and elements to measure such patterns within the business, as well as from identified competition
- Designing a set of actions and risk responses to be integrated in the core business plan, and clearly defining triggers for these actions via constant monitoring of aforementioned KPIs and metrics, and building a mathematical model to identify thresholds

The subsequent research questions can be formulated as follows:

- In what ways does the nature of the disruption events change with time?
- How does the change in nature of the disruption events affect the process of business planning and risk management for incumbent businesses?
- What internal capacities and skillsets do organizations need to build in order to implement effective disruption-based risk management?

1.2 Research Objectives

The chief objective of this research is to provide foundation work for building a comprehensive business planning framework that includes a portfolio of templates, best practices, processes and historical data repositories, integrated into the business planning and performance monitoring processes of technology investments and businesses. This framework shall enable businesses to plan, predict, detect, survive, and eventually join disruptive waves and evolutionary technologies. It shall also provide an addendum to existing standard business

planning practices for technology businesses, including the following business actions, for example:

- ***Strategic Risk Management:*** incumbent businesses will have greater visibility on risks emerging from competing disruptive innovations, and will be able to assess and quantify those risks as well as design response actions and strategies.
- ***Exit strategies:*** An incumbent business with investments in multiple technologies can benefit from reading the market trends before pumping additional investments into a certain product or technology. If the investment in an incumbent technology is already in place, businesses may be able to learn when it is the right time to withdraw and retire from a certain vertical, before it starts losing money.
- ***M&A decision making:*** Before acquiring a startup or merging with another business that benefits from or invests in certain types of innovation, it is important to evaluate their technology lifespan and potential. Being able to understand the risks from competing technologies can save these companies millions and help them avoid getting into a losing deal.
- ***Feasibility studies for new investments:*** Disruption-based strategic risk management can play an important role in the decision making and feasibility analysis process of evaluating new technology investments, such as building new product lines, recruiting a team of software engineers who specialize in a certain mobile platform, or redesigning an existing product.

1.3 Research Motivation

This research aims at revolutionizing the process of business planning and strategic business management by introducing a set of frameworks and best practices to enhance return on investments in the field of technology, and protect such investments from unforeseen losses and failures. It therefore positions itself at the very heart of the Technology Management discipline, and lays grounds for further research and development to standardize and perhaps even automate the process of managing disruption-related business risks and practices. Had this concept existed in a mature form a couple of decades ago, we would have probably been enjoying a number of the great brands that were killed by disruption in the 1980s and 1990s. Many of the industry giants failed to create and execute proper response plans for disruption-

related risks, despite the fact that they had been able to foresee and recognize those risks. The vast majority of innovation efforts are not disruptive (Charitou et al., 2012). In fact, some products have gone through so much innovation across the years that they have been completely transformed, but none of the innovations affecting them were disruptive. The sustainable innovation cycle is what businesses and companies must do in order to stay competitive. Sustainable innovation provides significant improvements, tweaks, additional functionality, and even new technologies, but without revolutionizing the product, or significantly changing its manufacturing process or customer base. Therefore, from a pure business vantage point, sustainable innovation is safer, more predictable, and more desirable. Still, everyone seems to be after the next big disruptive innovation— that big hit that will revolutionize an industry, and change the rules of the game.

The rest of this research paper is organized as follows. In Section 2, we provide an in depth literature review with a critical analysis on existing research work. Section 3 outlines our theoretical framework including three proposed new theorems. Section 4, 5, and 6 present our research methodology, results and discussions respectively. Section 7 concludes this research paper with current limitations and future research directions.

2. Literature Review

Research about “leading” disruptive innovation, facilitating innovation, or creating the right environment to foster and nurture innovation is indeed quite abundant (e.g., Kaplan, 2012 and Thomond, 2003). However, in this research, focus shall be made on *the other side of disruption*, or the companies and businesses facing disruption as shown in Figure 2 and Table 1. The upcoming sections will explore literature that focuses on anticipating disruption, responding to disruption, and the decision making process within companies and businesses being faced by a disruptive wave.

A natural entry point to the subject would be reviewing prominent literature and articles written and published by the man who coined the very term “Disruptive innovation”. Christensen (Christensen, 1997) argues that innovation is being held back by the vicious economical machine that is based on a set of hard-coded formulae designed to maximize the amount of *cash*. Senior business executives look at potential innovation opportunities from a purely



financial perspective, and therefore discourage all initiatives that attempt to stir significant investments for the sake of disruptive innovation, and try to create new products or services that can potentially disrupt their markets as well as add real *value* to those markets. Christensen distinctively differentiates between financial gain and *value*. A chief takeaway from Christensen's theories is the notion that business leaders need to think differently; they need to begin focusing on value rather than financial numbers. Christensen has been actively refining and enhancing his theory over the decades. His numerous published papers and books that followed the initial wave of books (the Dilemma and the Solution) have built upon the set of original thoughts, and has provided a much more robust framework for understanding and tackling disruptive innovation. Christensen suggests that the disruptive innovation enters the market to cater for the "lower-end" segment, and thus goes unnoticed by the incumbent players until it gains enough power to disrupt the incumbent players and technologies. This particular behavioral pattern may not be always accurate in the era of digital disruption, as this research paper will demonstrate. In fact, with the advent of digital disruption, many technologies were simply wiped out of the market because their disruptors were both cheaper and of better quality. Another important pillar in the literature review is the work by Moore (2011). His devised paradigm of "Systems of Engagement" as a tool to understand the future of enterprise IT is highly valuable as well as relevant in the context of this research. Moore's idea revolves around envisioning different types of *systems* in today's enterprise IT realm. These systems come in different *waves*. Initially, during the last decade of the twentieth century, the world's first major wave came with the advent of Personal Computers, combined with Enterprise Resource Planning Software (ERP) and the internet. The second wave arrived with the prolific use of smart phones combined with cloud infrastructure offerings becoming publicly available, along with cloud application hosting, or *Software as a Service* (SaaS). This introduced the second wave, known as *Systems of Engagement*. Moore also briefly explores a possible third wave, which he calls *Systems of Intelligence*. This wave is not going to be at the center stage of enterprise IT until the end of this decade or maybe beyond that. Moore predicts that Systems of Intelligence will prevail once IoT technologies become mainstream, which is not likely to happen unless and until smart sensors reach zero- or almost zero-cost, thus enabling a widespread ubiquitous use of "smart things". This, combined with strong analytics and machine learning, combined with the use of Private Clouds, will introduce the third wave,

Systems of Intelligence. The main takeaway from Moore's work in this research is the approach he suggests for "disruptee" businesses to react to the disruption process. He believes that disruptors should always hang around tier three of innovation –business model changing innovation. But if you are an incumbent business and you are about to be disrupted out of the market, you should never move up to third tier. Instead, you need to focus your efforts on the other two levels, particularly improving your operating model. Moore's approach to react to disruptive innovation, albeit highly controversial, provides a lot of depth and insight into the process of innovation, but one of the main weaknesses of his proposed approach to counter a disruptive wave of innovation is that he did not provide adequate data to prove its success.

Other notable research work include (Paap, 2004 ;Charitou et al. , 2012). Paap (2004) wrote a research on anticipating the arrival of a disruptive wave. His research employed an innovative dynamic model that takes into consideration the interaction between needs (drivers) and technology. He looked at several factors such as *leverage* (the extent to which an improvement would be perceived as adding value to the user), and *driver* (the main performance characteristic of the technology whose leverage is dominant or having greatest impact on potential customers). An important takeaway from this research is guidance on how to implement processes that can help a business anticipate and manage an event of disruption. One major criticism to Paap's work is the fact that his model lacks the historic dimension, and does not put the process of disruption into a repeatable, global context. Charitou et al. (2012) stress that it may be considered naïve for incumbent businesses faced by a disruptive wave to rush into riding the wave by embracing (or adopting) the same strategic innovations which caused the disruption. They state that other viable responses (which include completely ignoring the event) might constitute better options for business sustainability of well-established companies under some circumstances. The major weakness of their work was that they did not identify clear mechanisms for implementing the response evaluation framework within the incumbent organization to trigger the responses.

Other recent research works on disruptive innovation include the works of Tolido (2015), McKendrick (2015), Phillips (2014), Kaplan (2012), Lawrie et al. (2015), Thaler (2015), and Smink et al. (2015) who discussed several model for sustainable innovation and building corresponding organizational values. The reviewed literature hereinabove spans the entire life

cycle of disruptive innovation, albeit from a novel perspective –the perspective of the incumbent technology. This process includes understanding disruption (Christensen, 1997; Christensen, 2003; Moore, 2001), anticipating the event of disruption (Paap, 2004), and designing packaged responses/reactions to the event of disruption (Charitou et al., 2012). If an organization develops the built-in capability to predict and anticipate a disruptive wave of innovation that may risk its major revenue stream, designs prepackaged responses that can be triggered in the event of disruption, and is able to understand the real drivers and leverages of its own technologies, the risks of being impacted by a disruptive wave can be significantly reduced. However, reviewed literature has manifested some gaps that require further academic work to perfect this process. Such identified gaps include:

- A clear way to integrate the anticipation/identification/response process into the core business planning and operational process of the business.
- Identifying specific roles within the organizational hierarchy to own the process execution, and studying the nature of these roles, and whether there should be segregation of duties for different actions in the process, such as triggering action, choosing strategic response, and choosing the timing for response.
- Binding the anticipation/identification/response process to specific role(s) within the organizational hierarchy.
- Defining *triggers* – events that may signal the predefined actions, as well as identifying the decision-making points and roles within the hierarchy responsible for these decisions.

3. Theoretical Framework

This research presents a number of proposed theorems that collectively predict the behavioral patterns of disruptive innovation events. The work presented herein compliments the research work by Paap, J., & Katz, R. (2004). However, while the approach adopted by Paap & Katz focuses on product lifecycle, our approach adopts a more holistic outlook, which takes into account an entire “era” of innovation, examining the concurrent disruptive events and observing their common characteristics, such as the technology class, rather than focusing on one particular product or technology. The theorems presented herein are novel concepts based on observations and recent actual events. In addition to presenting the theorems, the research

presents a relationship model that correlates the different theorems together, and explains their rationale, significance, as well as relevancy within the context of the research, and in line with its objectives. The research also presents a quantitative method for evaluating the initial validity of the presented theorems via statistical methods. The theorems have one thing in common; they present an attempt to predict behavioral patterns of technological disruption events. This falls in line with the research's main objectives as it provides valuable tools for anticipating disruption events (from the incumbent's perspective) and preparing a proper response strategy for them.

A. Theorem #1: The Disruption Fabric

To lay the grounds of the fabric concept, we refer to commonly used terminology in the world of technology and business. Media and researchers often associate the term “disruption” with an adjective that describes the “*kind*” of disruption. The most commonly present example is “digital disruption”. Obviously, this association identifies the “*kind*” of disruption by designating the *technology medium* through which the disruption event takes place. We take upon this kind of association and extend it further to create a more specific definition of the disruption medium, where the class of technological innovation is identified for both the incumbent and disruptive technologies. The term “*digital disruption*”, which is commonly used in today's media and literature, fails to identify the nature of the disruption fully. It clearly implies that the new, disruptive technology is classified as “digital”. However, this term fails to identify the class of the incumbent, older technology being disrupted. A digital disruption event could be disrupting an analog technology, but it could also be disrupting another preexisting digital technology. Hence, the proposed “disruption medium” paradigm, which more accurately identifies the disruption context, by pinpointing the technology class for both disrupted and disrupting technologies.

Let us explore this proposed paradigm in greater depth. Take, for example, the digital camera sensor disruptive event. This disruptive event occurred by introducing a fully digital technology, which quickly and strongly managed to wipe out a global incumbent technology – silver halide 25mm film, a clearly analog technology. This disruption event could be best described under the proposed disruption media paradigm as an *analog/digital disruption*, rather than referring to it as merely digital disruption. Another example can be OLED displays, a

technology that managed to disrupt preexisting flat-display technologies such as TFT/LCD and plasma displays. However, in this case, both types of technology are purely digital in nature. Therefore, it would be more accurate to describe this event as a “digital/digital disruption”. Having established the “disruption medium” paradigm, we take the concept further and propose a likely relationship between the evolution of a disruption medium and time. This proposal constitutes the core element of the Disruption Fabric theorem. When a new technology class Y appears in the market and finds its way from test labs into consumer products, it begins a new wave of disruptive events which usually target an existing technology class X, and gradually pushes all class X technologies out of the consumer market. This process can also be regarded as a way to mark a technological era, where class Y technologies slowly transform from disruptive to incumbent – for example, the “digital era”. The X/Y disruptions start to appear as violent, sweeping disruption events, but as class Y technologies become more mature, there aren’t enough class X technologies to replace anymore. This is where we begin to see Y/Y type disruptions. As a second round of class replacement begins to appear after a new scientific breakthrough, a new technology class Z begins to find its way from test labs to consumer products, and slowly replaces all incumbent class Y technologies currently in the market, marking a new era. Again, The Y/Z disruptions start to appear as violent, sweeping disruption events, but as class Z technologies become more mature, there aren’t enough class Y technologies to replace anymore. This is where we begin to see Z/Z type disruptions. This interaction between the technology classes, disruption media, and time, is what we refer to as the Disruption Fabric.

We all witnessed a recent disruption fabric, and lived its events – the analog-digital fabric. When the industrial evolution introduced combustion-powered machines, engineering advances were mainly based on mechanical innovations that could be classified as belonging to the “mechanical category”. A few decades later, electrical control circuits appeared; a new wave of “electro-mechanical” innovations colonized the planet. But as Integrated Circuits (ICs) found their way from test labs to consumer products, digital control units quickly replaced electro-mechanical systems everywhere. This was happening around the 70s and 80s of the last century, where most of us were there to witness it with our own eyes. For example, a nice little Sony Walkman® portable cassette player was soon replaced by a much smaller, much cheaper,

and much easier to maintain MP3 player, that had no electrical motor, no analog signal processing, and no analog signal storage based on magnetic tapes and magnetic pulses. But as the digital technology class began to mature during the first decade of the 21st century, only a few analog technologies lingered around waiting to be disrupted, and it soon became more common to witness digital technologies, such as CD-ROMs, being disrupted by other digital technologies, such as DVDs and Blu-rays.

This pattern constitutes the essence of our proposed Disruption Fabric theorem. It also signifies a technological era. Eras started early in the human history. For example, there was a time where most of the human innovation was due to the fact that man was finally able to build tools using bronze instead of stone. Today, we affectionately call our time “the digital era” because of the prominence and abundance of digital innovation.

What will be the next fabric? Nobody knows of course, but we can only imagine and guess. For instance, we might be on the verge of a new Digital/Quantum disruption fabric. The first sign of the fabric is already manifesting itself in the form of digital/digital medium saturation – almost all new innovations are replacing older technologies that already belong to the same technological class. But once the first quantum-based innovation finds its way out of the test labs and into consumer products, a new era will break through, and a new wave of digital/quantum disruptive innovations will sweep through the consumer market, possibly wiping out some incumbent technologies and businesses on its way. This wave is characterized by the new, hypothetical digital/quantum disruption medium, which will in turn characterize the beginning of the new quantum-led disruption fabric. From the above discussion, we can derive some definitions for the terms introduced in this theorem as shown in Table 2.

The Disruption Fabric theorem presents a unique perspective of relating and categorizing disruptive events in relationship with time. In the context of disruptive innovation related business risk management, this theorem can provide a clearer perspective and a deeper understanding of the risk magnitude. One example could be understanding the maturity of the current fabric, and watching out for potentially imminent new disruption waves emerging from new technologies that find their way out of the test lab and into the consumer market. To better

contextualize the risk magnitude in correlation with a certain disruption fabric, we also need to understand the potential “size” of a disruptive wave. In other words, we need a tool to visualize and estimate the potential impact of an upcoming series of disruptive events. And this is exactly what we attempt to do with the next theorem. Figure 2 depicts a visual representation of a fabric. We chose the most coherent, most current, { analog \rightarrow digital } fabric for this representation. On the vertical axis, the incumbent technology class is represented, while the disruptor technology class is represented on the horizontal axis. The intersection of the two axes yields a *disruption medium*. The arrow shows the chronological relationship between the various represented disruption quadrants (each quadrant representing a separate disruption medium). Naturally, the end of the fabric should be accompanied by the introduction of a new fabric.

B. Theorem #2: The Frequency/Amplitude Theorem

This theorem presents an attempt to model the frequency of disruptive events within the same disruption medium, as well as their perceived impact on the market. The theorem presents a model for the frequency and impact (amplitude) of disruption events within the fabric, where the strongest wave of events accompanies the advent of an X/Y type disruption medium, or in other words, the introduction of a new technology class into the consumer market. The high impact disruption events will result in serious destabilization of markets and businesses dependent on the incumbent technologies being disrupted. Therefore, they are regarded as high-impact (or high-amplitude) disruption events. As the maturity of the fabric increases with time, the impact of upcoming disruption events will decrease, and therefore their effect on existing businesses and technology investments will be less severe, but the frequency of disruption events will increase. Towards the end of the fabric’s lifetime (i.e., saturation) the disruption events will be a lot more frequent, but their impact on existing businesses and technology investments will be less significant, and less damaging. This becomes especially evident as the disruption fabric reaches its final stage, i.e., a Y/Y type disruption medium.

Adopting the Frequency/Amplitude paradigm requires a slight shift in mindset from the currently prevailing mainstream literature and terminology in the field of studying disruptive innovation. Most existing literature will classify innovations into either disruptive or sustainable, marking certain instances of innovation as “non-disruptive”. This contradicts the

paradigm proposed herein, because it regards all real innovation as disruptive, albeit with different scales (or amplitudes). According to the proposed paradigm, if a new technology finds its way to the consumer market, it must be replacing some existing technology, given that demand is constant. The Frequency/Amplitude theorem complements the Disruption Fabric theorem, and provides another dimension to the process of analyzing and predicting the nature of disruption events. The significance of the Frequency/Amplitude paradigm is manifested in its greater ability to model and quantify strategic risks associated with potential disruption events from an incumbent's point of view. Combining the two paradigms, strategic risk managers for incumbent technology businesses can provide risk models with greater accuracy and higher business relevancy.

C. Theorem #3: Innovation Proximity

The Innovation Proximity paradigm introduces a new dimension to the space of disruptive innovation by adding a new characteristic that classifies different events of innovation according to their proximity to the core product or technology used. In this model, we suggest four different levels of innovation proximity:

- **Proximity Level 1:** Innovation in the product itself, or in the product's underlying technology. For example, xenon headlights, hybrid automobiles, and digital cameras are all considered level 1 innovations, because they present a change in the core technology of the product.
- **Proximity Level 2:** Innovation in the methods or technologies used to build the product. The most prominent example is the use of robotics to assemble cars. Although the car itself would still be virtually the same, developing the way it is manufactured can have its implications on the unit cost, quality, and production capability. Another prominent example of level 2 innovation proximity is the use of Rapid Application Development (RAD) methods in software manufacturing. A third example from the world of software engineering is the collaboration and workflow platforms, such as Microsoft SharePoint and K2.net, which can be used to build enterprise and Internet solutions with higher quality and faster time to market.

- **Proximity Level 3:** Innovation in logistics and delivery. This category includes many examples of recent disruptive innovations. For example, the Uber car service is considered revolutionary, despite the fact that Uber did not really invent anything new in terms of core product technology. The vehicles used are the same as the ones used by any other taxi service, and the mobile app platform uses the same technology that has been around for years. However, the real innovation in Uber comes in the way the service is delivered to the customer, and how the service level is maintained and monitored through the online system. In recent years, the Uber brand is becoming synonymous to the word “disruption”, despite the fact that they did not really introduce any new technologies per se. Other remarkable level 3 examples include DHL’s revolutionary package identification barcode system, which was introduced more than three decades ago, and revolutionized the entire freight industry. In the field of information technology, examples of Level 3 innovations include online software distribution and online music stores, which are also considered highly disruptive, despite very little or no technological innovation involved.
- **Proximity Level 4:** Innovation in product offering, sales or marketing. This is the farthest level of innovation from the core product. Nonetheless, it can be the most impactful and disruptive. Level 4 proximity innovations are quite common in today’s world. For example, telecom operators make billions of dollars from simple innovations in tariffs and rate plans such as per-second tariffs, where customers pay for voice calls per second instead of per minute.

In the world of software, the introduction of in-app purchase concept has been one of the most disruptive innovations in the software industry during the past five years, despite not being a real technological innovation. Today, the entire gaming industry is transforming based on this concept, and other software verticals are also drawn to the same concept. Level 4 proximity innovations are having significant impacts on the industry, with many of the recent disruptions occurring at this level. One of the most disruptive new concepts in the world of software industry today is the X As A Service (XaaS) concept, which offers a vast spectrum of technology, platform, and software solutions in the form of subscription-based services rather than purchased licenses. For instance, Microsoft’s renowned Office® suite is now offered to users as a subscription-based service, known as Office365™. Subscribers to the Office365



service get nothing new; they still get the same old Office products and technologies, except that they no longer purchase the license; they simply pay an annual *subscription*. By presenting these new offerings, software companies are able to reach out to new customer segments, scale up or down based on customers' needs, and provide their customers better services while optimizing IT related expenditure.

The following quick comparison outlines the four different levels of innovation proximity, and presents the unique characteristics of each level.

From a theoretical perspective, if we attempt to identify a pattern that binds the behavior described by the fabric theorem to the characteristic introduced by the proximity paradigm, we may will that there can indeed be a correlation. We will use a mental experiment to model the outcome of a full disruption fabric lifecycle. As discussed earlier, the pinnacle of the fabric ensues at the introduction of an X/Y type disruption medium, which occurs due to the introduction of a new technological innovation into the market. This means a ripe opportunity for level 1 proximity disruption events. In contrast, as the fabric grows old, and approaches the end of its lifetime, it matures into a Y/Y type disruption medium as the preceding X/Y type medium begins to reach saturation. This leaves very little space for innovation at the core of the products, i.e., level 1 proximity innovation, but it opens doors to new types of innovation that can still disrupt the market, albeit without even touching the core product or technology that sits at the heart of the innovation event. In fact, proximity of disruptive innovation events may be inversely correlated to the maturity of the fabric – a hypothesis the proof of which may be beyond the current scope of this research. To summarize, we hypothesize that level 1 proximity events will be more common at the pinnacle of a disruption fabric, i.e., when a fresh new Technology Class enters the consumer market. As the fabric matures, distance from the core product or technology increases, and innovation events take place away from the core more often.

4. Methodology

To examine the validity of the presented theorems, numerous approaches can be adopted, with varying precisions and efficiencies. Perhaps the most accurate way to prove the presented

theorems would be to collect historical data regarding major innovations and notable disruption events in different fields in the past five decades, and analyze patterns of disruption impact, frequency, and proximity. This preferred approach is out of the current scope of this research, which presents the theorems discussed in the previous section, and provides feedback from relevant industry innovators and top management. The approach we adopt consists of a number of steps:

1. Break down each theorem into simpler paradigms that can be mapped to individual perceptions. For example, the first sub-paradigm of the fabric theorem would be “digital innovations used to disrupt analog innovations more often in the 80s and 90s of the previous century”, while the second sub-paradigm would be “digital innovations tend to disrupt other digital innovations during the current decade”.
2. For each constituent paradigm, we develop a hypothesis to be tested. A survey is built to present a data sample that can be used to test the aforementioned developed hypotheses.
3. Statistical analysis methods are used to test the applicability of the results on the larger population of incumbent technology top managers. Providing statistical evidence that supports the constituent hypotheses is a first step towards considering the presented theorems and therefore studying them further.

The scope of this research includes five hypotheses, five experiments, and seven survey questions including:

Hypothesis H_1

This hypothesis is designed as an initial, preliminary examination of the validity of the Disruption Fabric theorem. The text of the hypothesis states that “*The majority of incumbent technology top managers will express the perception of dominance of the Analog/Digital disruption medium during the 80s and 90s of the twentieth century, while simultaneously expressing a perception of dominance of the Digital/Digital disruption medium during the current decade*”.

To test hypothesis H_1 , we are going to break it down into two hypotheses and test them individually, then we will test the combined hypothesis.

Hypothesis H_{2a}

“The majority of incumbent technology top managers believe that strong disruptive innovations came to the market after the invention of ICs in the 70s, but the intensity of these disruptions went down with time”. Testing this hypothesis will provide support to the Frequency/Amplitude theorem.

Hypothesis H_{2b}

The hypothesis states that: *“The majority of incumbent technology top managers expect to see mainly low-impact innovations in their field in the next year or two”*. Testing this hypothesis reinforces the notion that the current fabric is reaching reasonable maturity. It also provides further support to the Frequency/Amplitude theorem.

Hypothesis H₃

The hypothesis states that: *“The majority of incumbent technology top managers anticipate that the next major innovation in their industry will not be at the core of the product or technology, i.e., not a proximity 1 type of innovation”*. Testing this hypothesis will provide initial, preliminary guidance regarding the validity of the Innovation Proximity theorem.

Hypothesis H₄

“Amongst top managers currently in organizations that consume and/or invest in incumbent technologies, the majority do not have, or are not aware of, a role that is dedicated to observing strategic business risks emerging from new innovations”.

Hypothesis H₅

“Amongst top managers in organizations that consume and/or invest in incumbent technologies, the majority believe that there should be a separation of roles in the organization between the role(s) responsible for analyzing, detecting, and monitoring the market for threatening new competitor innovations, and the role(s) that will “lead” the effort to protect the business from such risks”.

Research Framework Parameters

Table 3 summarizes the framework parameters for the full set of hypotheses presented. The parameters are categorized based on their relation to the hypotheses. Each parameter is coded and is given a list of possible values to be assigned to it. Furthermore, the table below illustrates the hypothesized parameter value (the value assigned based on the corresponding hypothesis).

Hypothesized values are presented below in bold font. Whenever the hypothesis proposes more than one value, the unlikely values are grayed out.

5. Results

This research uses a number of tools for data collection, analysis, and validation. Prior to designing the survey, a number of unstructured interviews were conducted with a small selected sample. The main purpose of the preliminary interviews was to obtain the best possible format for the survey questions, their order, language, structure, etc. Prior to sharing the survey topic, the interviewees were briefed about the full spectrum of the research and its objectives. The selected sample mainly consisted of top managers that have had extensive working experience in the innovation field (10+ years of experience). The outcome of the preliminary interviews was used to restructure and shape the final version of the survey. The main data collection instrument used for this research was a short survey. The survey is designed to meet certain objectives explained in detail below. The sampling frame includes all incumbent business technology top managers, i.e., top managers (CEOs, CTOs and/or Innovation project managers) who work in existing businesses that benefit from and/or invest in existing (incumbent) technological innovations. Individuals from both genders are included in the sampling frame. There were no age restrictions other than those implied by the suitability of jobs. We aimed for a sample size of at least 250 subjects. There were no geographical restrictions on the location of the subjects. The survey was cross-sectional and the sampling frame is considered as a cluster, because no particular stratification technique was used within the targeted sampling frame. Out of the original 250 records sampled from the online survey, blank or incomplete entries were cleansed, and the remaining 211 records were used for the sample. After conducting inferential hypothesis testing, Figure 7 illustrates the relationship between the different research components, namely, proposed theorems (presented below as T_n), related hypotheses (presented below as H_n), and corresponding statistical significance. Data was analyzed by using the SPSS software. Confirmatory factor Analysis (items below 0.40 were dropped) was used to check validity of research instrument and regression and one-sample t-tests to test each hypothesis. The reliability of the instrument was ensured through acceptable values of Cronbach 's alpha. Overall reliability is 0.915 which is extremely good.

As noted in Figure 7, the statistical hypothesis testing allowed us to reject all the proposed null hypothesis with medium to high levels of significance. Also, an interesting phenomenon manifested within the sample data. Quite remarkably, the number of user choices associated with different proximity levels has increased as we moved away from the core in a clear pattern that is quite consistent with the essence of the disruption proximity paradigm presented hereinabove. This is yet another reinforcing observation as shown in Figure 8.

6. Discussion & Implications

The results of survey data analysis provide some confidence in the Disruption Fabric paradigm presented earlier. Additionally, analysis results were also consistent with the Frequency/Amplitude paradigm, which suggests that disruption events change in nature, frequency, and market impact relative to time. The combination of the Disruption Fabric and the Frequency/Amplitude paradigms provides a basic model that allows long-term business planners to exploit market data specific to their vertical, and implement more robust and bulletproof strategic risk management plans. Additionally, research results show with a reasonable degree of confidence that the current decade falls closer to the end of a Disruption Fabric lifespan. This calls for risk managers to keep an open eye for new technology classes that find their way to the consumer market.

Patterns suggested by the Disruption Fabric and the Frequency/Amplitude theorems are consistent with real world observations. A cassette player could stay in the market for 3 decades without any significant competition, and with only cosmetic updates. MP3 players do not enjoy the same level of safety nowadays. Disruptive innovations that exploit newly introduced Technology Classes start out as rare and far apart. Therefore, their impact on the market can be quite significant. Conversely, as disruption events become more frequent, their impact on the market gets *diluted*. This only makes sense because the market only has so much potential for “major” disruptions. The economy and production dynamics will end up balancing against new innovations, reaching some sort of equilibrium in the market, and distributing market share between newly introduced innovations – hence the proposed “dilution” effect.



Proximity Paradigm: Applications in Business Planning

Data analysis results yield two significant conclusions that are relevant to the Disruption Proximity paradigm. The first one is the fact that disruption-based strategic risks do not have to originate from innovations in the core technology. In fact, primary data has shown that most top managers anticipate such disruptions to occur *anywhere* but in the core product technology. Furthermore, primary data has shown that the probability of a significantly disruptive innovation increases as we move farther from the core technology. The second important takeaway from primary data analysis results is the fact that business risk monitoring should change focus from the core technology to other channels, such as logistics and marketing. This means that the internal roles responsible for assessing, evaluating and reporting potential disruptive risks should no longer come from the engineering team; they should be from a wider spectrum of roles within the organization, such as logistics and/or marketing.

Reflections on Organizational Structure

Finally, two important recommended practices in the area of strategic business risk management can be derived from the primary research data analysis. First, the organizational strategic risk management unit should have separate roles for observing risks and others for acting upon those risks. In other words, the “watchdog” or “trigger” roles should be separated from the “actor/leader” roles. The second important recommended practice is to have multiple individuals assuming the “watchdog/trigger” role within the organization’s strategic risk unit. These multiple individuals should come from different practices within the organization. i.e., from engineering, logistics, marketing, sales, as well as finance. Ideally, the watchdog function should be executed by a committee that reports directly to the CEO, and depending on the perceived immanency of a strategic risk, the committee should present a quarterly, semi-annual, or annual report to the senior management, outlining all potential disruption-based strategic risks in the market, and detailing exposures, probabilities and response strategies for each.

7. Limitations and Further Research

This research is intended to serve as a groundwork for further, more in-depth academic work to help establish the concept of disruption-based business and risk planning. The findings and conclusions of this research are expected to present a proposed business framework and a set of guidelines and best practices for long-term business plan design and implementation. We identified three major constituents (as shown in Figure 9) of a successful disruption-based strategic risk management methodology: permanent organizational roles to monitor and respond to risks, processes to enforce monitoring and proactive planning, and metrics to assess risks and measure effectiveness of implemented actions.

While this research provides recommendations and ideas for roles to drive the process and trigger the responses, it paves the way for further work to cover the two remaining components, process and metrics. Further work can cover historical analysis of disruptive innovation events, integrated long-term business planning practices which adopt disruption-aware risk management as an integral part of the business planning process, and formal processes for proactive risk response planning, including the definition and documentation of predefined response strategies. Finally, the metrics constituent also needs to be examined further. Organizational metrics for businesses that benefit from and/or invest in incumbent technological innovations must have adequate disruption-related metrics embedded into their KPIs, such as indicators for immanency of potential disruption events, estimated impact of anticipated disruptions, and potential coverage of implemented risk mitigation strategies.



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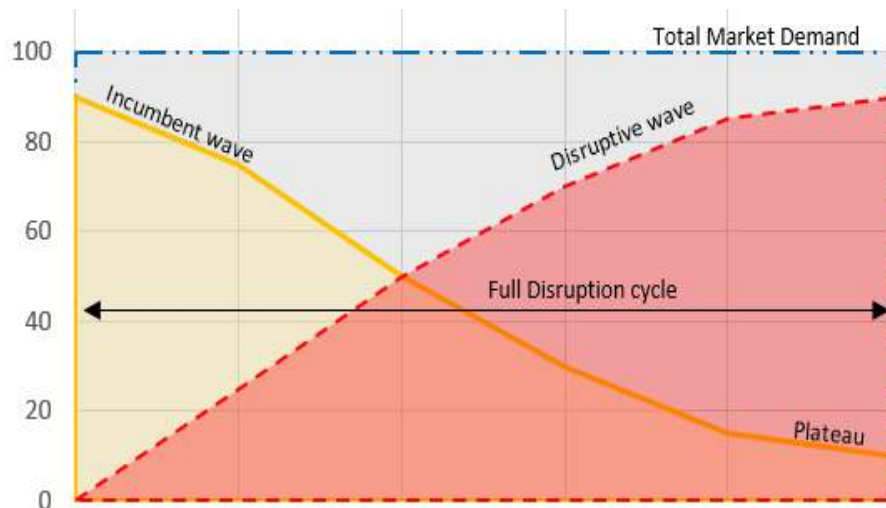


Figure 1: Anatomy of the disruption event: Incumbent wave vs. Disruptive wave

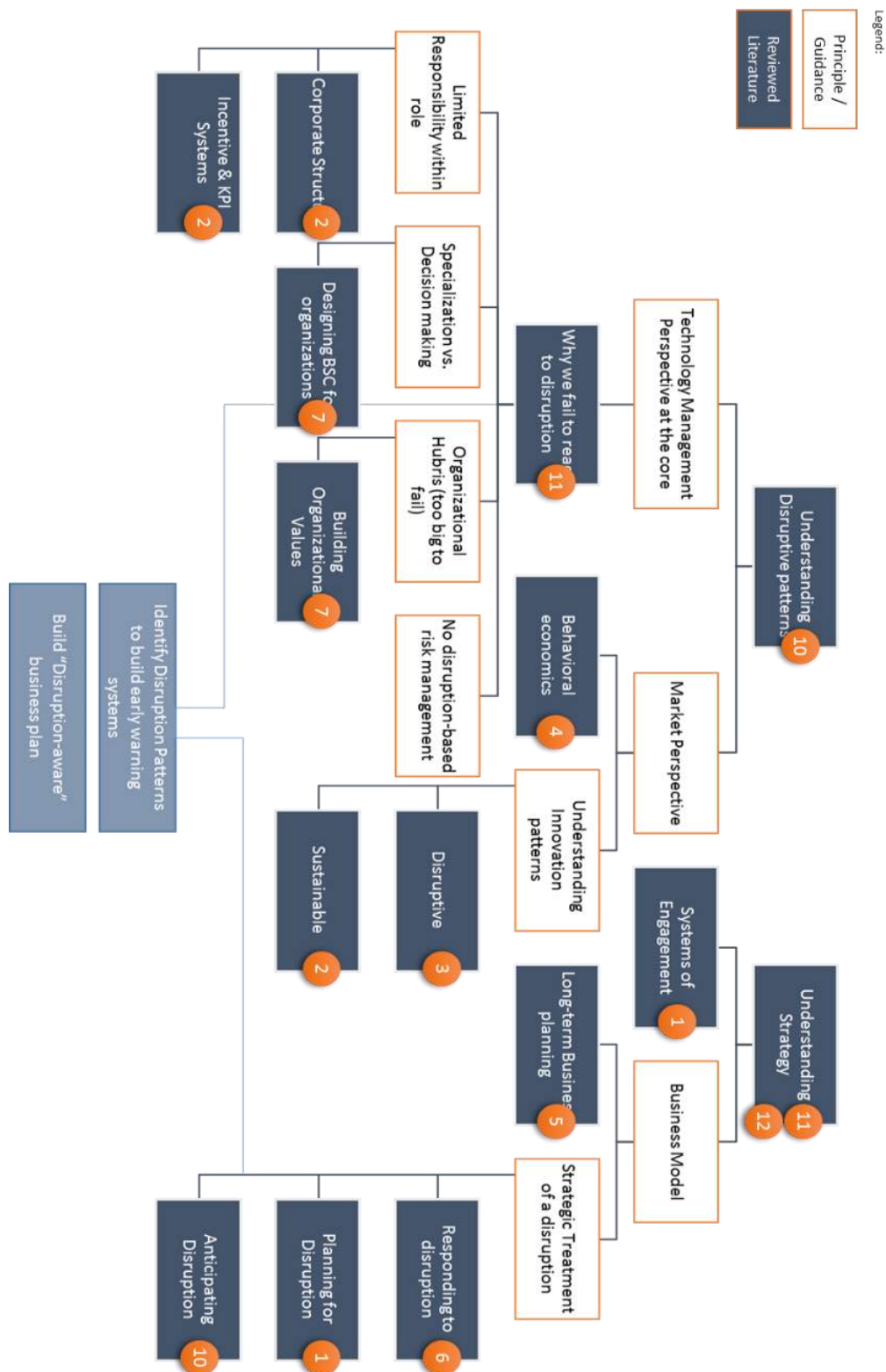


Figure 2: Literature Review logical mapping (Partial view). Refer to Table 1. For Key mappings.

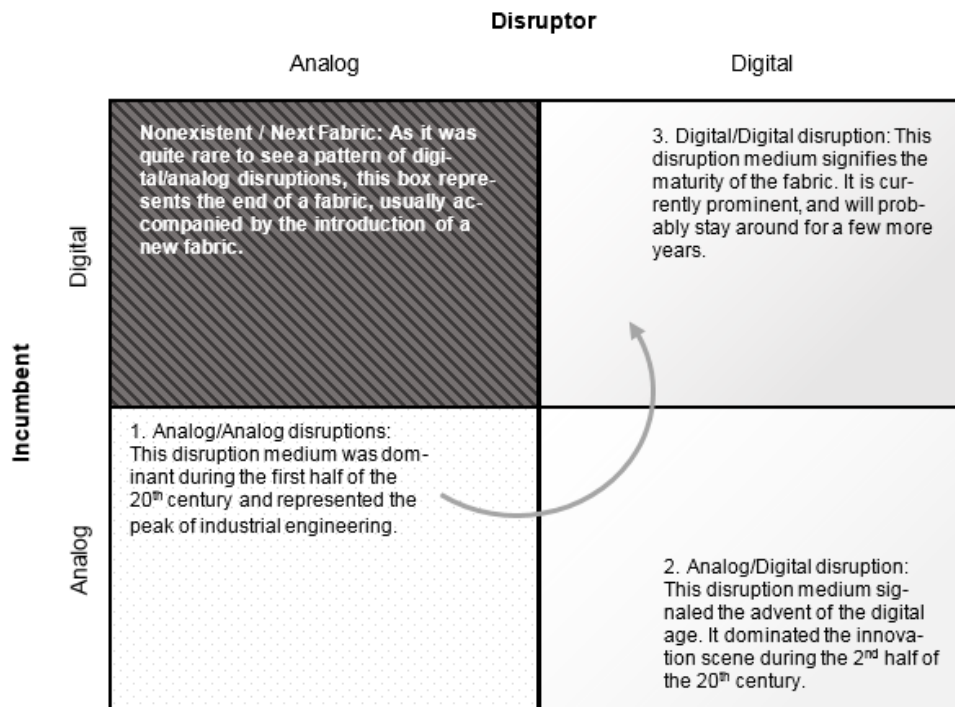


Figure 3: Fabric diagram showing the { Analog → Digital } fabric.

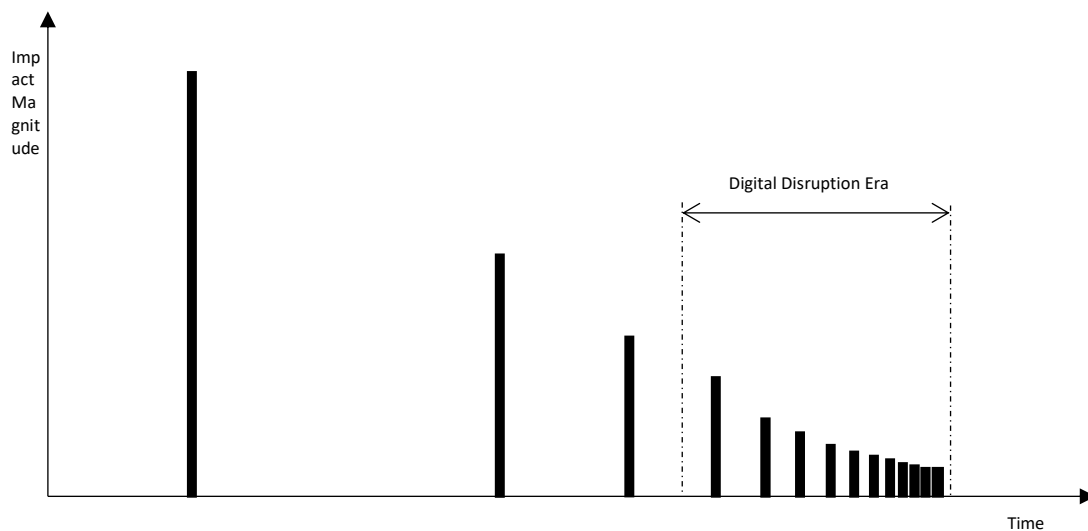


Figure 4: A visual representation of the frequency/amplitude modelling for disruptive innovation events relative to time.

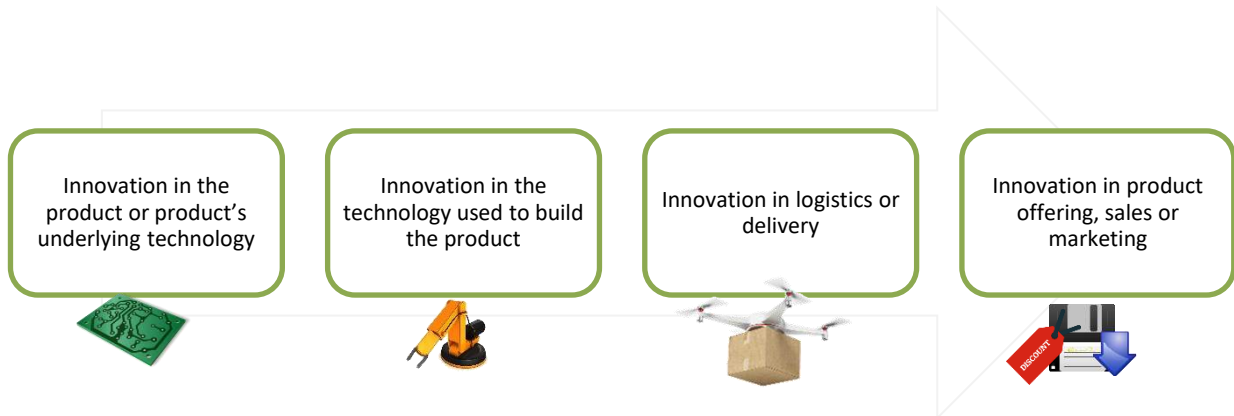


Figure 5: Innovation Proximity Theorem – different levels and examples

Innovation Proximity Level	Impact	Example
Level 1: Innovation in the product or product's underlying technology	More or better features	Xenon lights
	Cheaper production cost	Run-flat tires
Level 2: Innovation in the technology used to build the product	Cheaper production cost	Software App builders
	Higher quality	Robots on production lines
Level 3: Innovation in logistics or delivery	Cheaper cost to consumer	Amazon drones
	Faster time-to-customer	DHL barcodes
Level 4: Innovation in product offering, sales or marketing	Better customer perception	Subscription-based CRM
	Higher value	Per-second prepaid voice plans

Figure 6: Summary of the different proximity levels

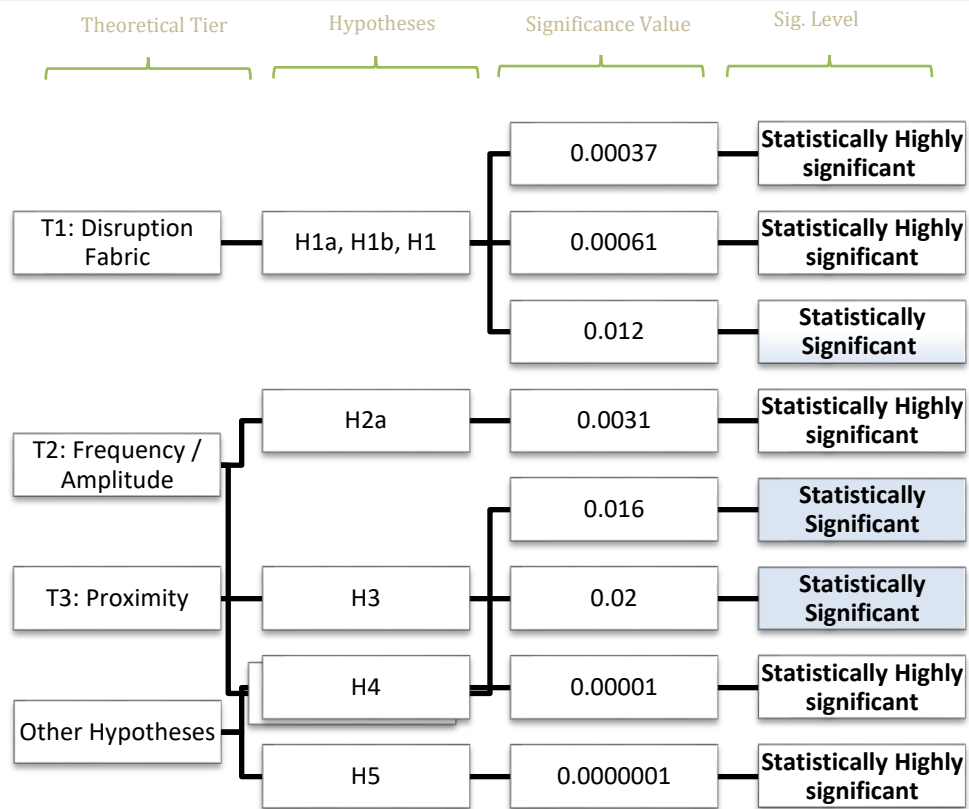


Figure 7: Hierarchical chart showing relationship between research components.

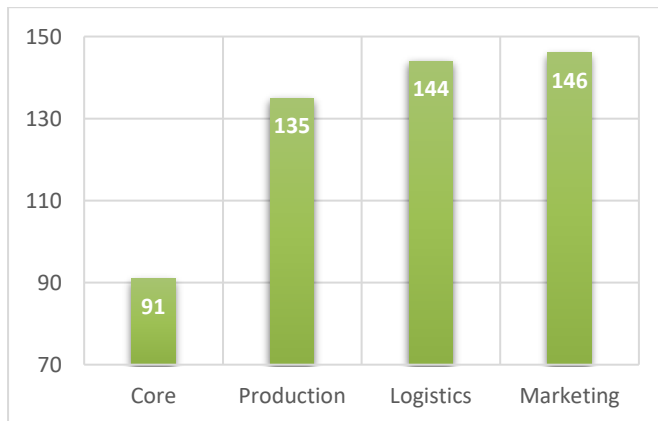


Figure 8: Results of the Innovation Proximity experiment.

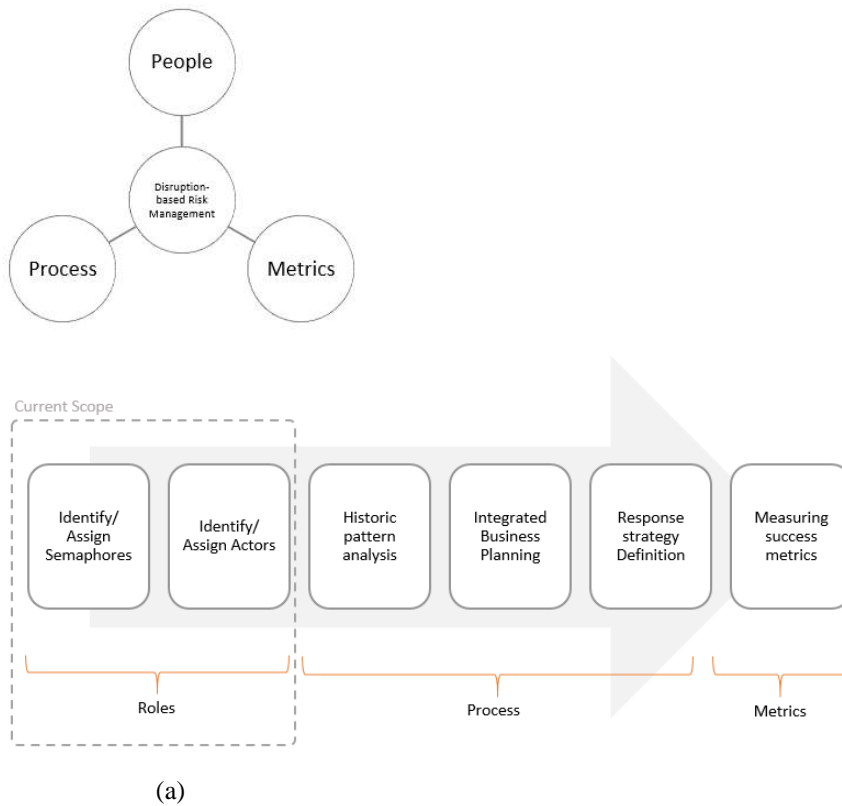


Figure 9: (a) Three constituents of disruption-based risk management. (b) Roadmap for building a disruption-based risk management framework.

Table 1. Key Mappings to existing related work (Partial View).

Key	Related work
1	Moore (2011)
2	Smink et al. (2015)
3	Markides (2006)
4	Thaler (2015)
5	Bradfield et al. (2005)
6	Charitou et al. (2012)
7	Lawrie et al. (2015)
10	Paap et al. (2004)
11	Christensen (1997)
12	Christensen, C., & Raynor, M. (2003)

Table 2. Definition of Terms in Theorem 1

Technology Class	A common characteristic, generally predominant during a certain era that can clearly and uniquely identify the majority of new technologies and innovations introduced during that era.
Disruption Medium	A paradigm that identifies the disruption context more accurately, by pinpointing the technology class for both disrupted and disrupting technologies.
Disruption Fabric	A paradigm that assumes a transitional, progressive pattern relating different disruption media, and predicting their behavior. For instance, the {analog→digital} disruption pattern consists of three different disruption media (i.e., analog/analog, analog/digital, and digital/digital), and relates their behavior and progression. In effect, a fabric shall only include one unique disruption medium, because any X/X or Y/Y type disruption medium will be shared either with a previous fabric, or with an upcoming one.

Table 3. A summary of the framework parameters

	Category	Framework Variable	Var code	Possible values
1	Next Disruption event characteristic from the Fabric Theorem viewpoint	Current Fabric quadrant	DF	Analog/analog Analog/digital Digital/digital
2	Next Disruption event characteristic from the frequency/amplitude perspective	Perceived Impact	AMP	High Low
		Perceived interval (since previous disruption within the same fabric)	FRQ	Long Short
3	Next Disruption event characteristic from the proximity theorem perspective	Proximity type	PRX	Core Build Logistical Offering
4	Organizational characteristic from a disruption-based risk management perspective	Current Trigger role	TR	Existent Nonexistent
		Current Actor role	AC	Existent Nonexistent
		Trigger/actor role separation	SE	Yes No



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